Sept. 15, 1931. T. V. HEMMINGSEN 1,823,399

SCAVENGING FOR TWO-STROKE INTERNAL COMBUSTION ENGINES

Filed Oct. 8, 1928

Fig. 1.

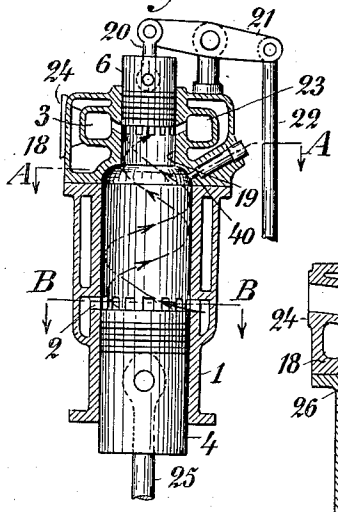


Fig. 2.

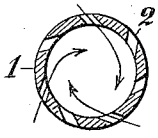


Fig. 3.

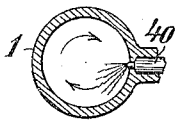
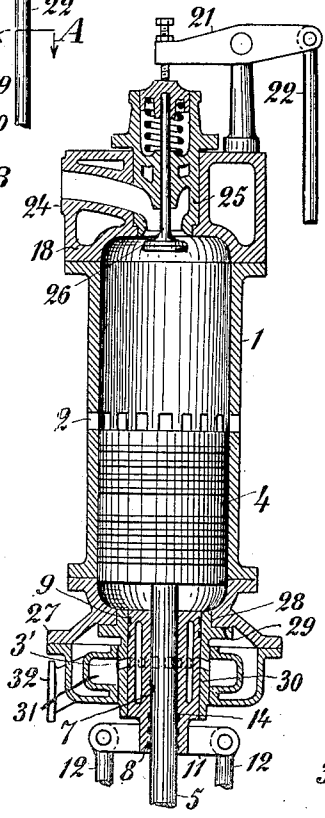


Fig. 4.



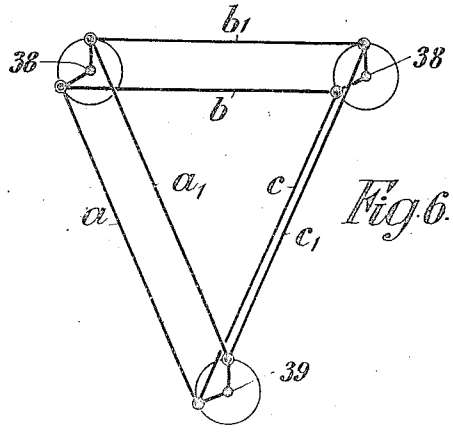
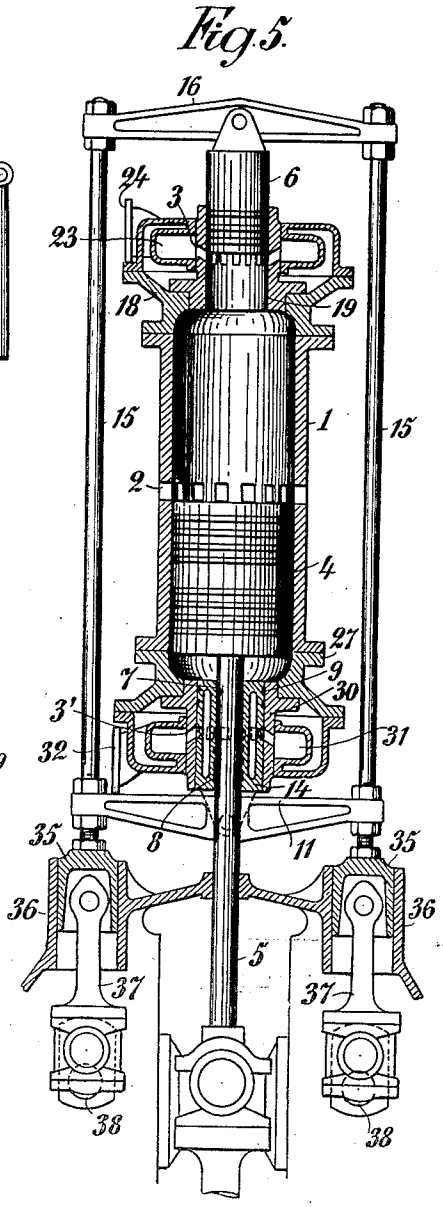


Fig. 6.

Fig. 5.



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UNITED STATES PATENT OFFICE

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SCAVENGING FOR TWO-STROKE INTERNAL COMBUSTION ENGINES

Application filed October 8, 1928, Serial No. 311,204, and in Denmark October 28, 1927.

This invention relates to an arrangement of scavenging applicable in both single-acting and double-acting two-stroke cycle internal combustion engines. The arrangement is of that kind in which scavenging takes place through ports or the like openings. Internal combustion engines with scavenging through ports have the drawback that it is difficult to keep those parts of the cylinder close to the exhaust ports well oiled, these parts being intensely heated by the passing exhaust gases, so that the oil becomes thin and is easily carried away with the exhaust gases. This is objectionable especially because the main part of the piston passes the part in question of the cylinder with the greatest speed. The importance of this drawback is highly increased when the scavenging is defective, because the said parts of the cylinder are then especially intensely heated. According to the invention the said drawback is avoided thereby that the scavenging ports of the cylinder are controlled by a power piston, while the exhaust ports are controlled by one or more special controlling pistons having an essentially lower speed than the power piston, and besides the scavenging ports are so shaped that their directions are tangents to a cylindrical surface placed within the cylinder wall and coaxial therewith. Hereby it is made possible to make the speed of the power piston as great as it might be found practical, which means that a certain output may be obtained by smaller dimensions of the engine. By shaping the scavenging ports in the above mentioned manner it is obtained in a known manner that the scavenging air gets a rotating motion at its admission and moves up through the cylinder in a helical current. Hereby is obtained a very efficient scavenging, the combustion gases being practically fully exhausted from the cylinder in each working period, and the cylinder is filled with pure scavenging air. This means that the walls of the engine cylinder are permanently kept at a comparatively low temperature, the fresh air being able to bring its cooling power to bear at a very high degree, and it is obtained that the bounding of the piston speed caused by a deficient cooling is avoided. The invention consists in the combination of the said arrangements and may be characterized mainly thereby that the scavenging ports form tangents to a cylindric surface located within the inner wall of the engine cylinder and coaxial therewith, and that they are controlled by the power piston, whereby the exhaust ports are situated at the other end of the cylinder and are controlled by one or more special controlling pistons, the speed of which is essentially smaller than that of the power piston. The diameter of the controlling piston or pistons may, according to the invention be identical with that of the working piston or may differ materially from this diameter. Preferably it is made substantially smaller in diameter. The controlling piston or pistons may in certain cases be provided with a bored hole, through which the piston rod of the working piston passes, the said bore being made to fit tightly on the piston rod by means of packing rings, piston rings or the like mounted, for instance, inside the bore and possessing a certain amount of tension, so as to make them exert pressure on the piston rod. The controlling piston or pistons are connected by suitable link rods or the like with one or more secondary shafts or to the main shaft of the engine, directly or indirectly. The motion of the controlling piston or pistons is preferably parallel to the direction of motion of the working piston, but the arrangement may also be such that the axes of the controlling pistons are situated at suitable angles to the axis of the working piston. The motion of the controlling piston or pistons proceeds with the same cycle as that of the working piston but in a reverse or nearly reverse direction in relation to the direction of the latter, as the motion of the controlling piston is preferably displaced by a suitable small angle in advance of the motion of the working piston in such a manner that the exhaust ports are uncovered before the scavenging air ports at the beginning of the scavenging period, while at the end of this period the exhaust ports are covered before the scavenging air ports. Thus it becomes possible

at the close of the scavenging period to have a pressure higher than atmospheric in the cylinder, namely a pressure corresponding to the scavenging pressure, which will serve to increase the output of the cylinder ("supercharge"). The cylinder cover or covers of the egnine may be provided with a special cylinder for the controlling piston or pistons, and exhaust ports may then be arranged in this special cylinder. In double-acting engines it may be sufficient, instead of having a controlling piston or a set of such pistons in each end of the cylinder, to let the bottom end of the cylinder be served by one or more controlling pistons, the exhaust port or ports in the top end of the cylinder being then controlled by valves or the like. If controlling pistons are employed to serve both ends of the cylinder, these two pistons or sets of pistons may be connected by suitable mechanisms so as to make them move to time, that is, in the same cycle, while the motion of any of the two pistons or groups of pistons may otherwise proceed in accordance with its individual law of motion. The said two pistons or groups of pistons may also, however, be rigidly connected with each other, for instance by means of a crosshead beam and rod connection, so that their motions coincide. The cylinder or cylinder cover may be provided with one or more injecting nozzles through which fuel is admitted to the cylinder in directions either entirely or partly following the whirling motion of the scavenging air or being entirely or partly opposite to this latter motion. The invention is illustrated in the drawings, in which Fig. 1 shows a longitudinal sectional view of a constructional form of the arrangement according to the invention, Figs. 2 and 3 show sectional views of the arrangement shown in Fig. 1, on lines B—B and A—A respectively, Figs. 4 and 5 show sectional views of two modified constructional forms of the invention, and Fig. 6 shows a diagrammatical view of a link rod connection between the main crank shaft and two secondary or intermediary shafts connected with the controlling piston or pistons. In the arrangement for scavenging shown in Figs. 1, 2 and 3 for single-acting engines, the reference character 1 indicates the cylinder, 2 the scavenging air ports, 3 the exhaust ports and 4 the working piston. The exhaust ports 3 are arranged in the cylinder cover 18 which has a cylindrical bore 19, through which the controlling piston 6 may move. The motion of the controlling piston 6 is governed by a secondary or intermediary shaft (not shown) by means of a link piece 20, a lever or rocker 21 and a link rod 22. Surrounding the exhaust ports 3 an annular space 23 is provided through which the combustion products are led to a flange 24 connecting the exhaust pipe. 25 indicates the connecting rod by means of which the motion of the working piston 4 is transferred to the engine crank shaft (not shown). The latter and the secondary shaft controlling the motion of the auxiliary piston 6 are mutually positively connected in such a way that the two pistons 4 and 6 operate in the same cycle, but chiefly in opposite directions. The exhaust ports 3 are preferably uncovered a short time prior to the scavenging air ports 2. As may be seen from Fig. 2 the latter ports have such tangential directions that the scavenging air when admitted obtains a helical whirling motion as indicated by the arrows in Figs. 1 and 2. Instead of being directed perpendicular to the cylinder axis, as shown on the drawings, the ports 2 may be obliquely directed so as to form suitable smaller angles with the cylinder axis. 40 indicates a fuel valve mounted in the cylinder cover 18 through which valve the fuel is injected in a direction substantially coinciding with the direction of the whirling motion of the air stream, as indicated in Fig. 3. In the constructional form illustrated in Fig. 4, which is intended to be used in double-acting engines, the scavenging air ports 2 are situated at the middle of the cylinder 1 and are covered and uncovered by the working piston 4 which in its dead centre positions alternately uncovers these ports by its upper and lower edges, so that scavenging is done alternately in the upper and in the lower half of the cylinder. In this constructional form the cylinder has no controlling or distributing piston serving its upper half, but is provided with an exhaust valve 26 mounted in the centrally arranged hollow space 25 of the upper cover 18. The valve 26 is actuated from the cam shaft of the motor (not shown) through the medium of the lever or rocker 21 and the rod 22, in such a manner that the valve is caused to remain open during the scavenging period, the valve opening near the close of the piston stroke, a very short time before the working piston 4 uncovers the scavenging ports 2. The products of combustion are then expelled through the valve 26 to the exhaust pipe which is connected by means of the connecting piece 24. At its bottom end the cylinder 1 is provided with an annular cover 27 with a circular aperture 28 and a flat face 29 for the purpose of receiving a cylinder 30 provided with exhaust ports 3'. The controlling or distributing piston 14 reciprocates within the cylinder 30, its motion being effected from the main shaft or a secondary shaft by means of a crosshead beam 11 and rods 12. The controlling or distributing piston 14 is provided with hollow internal spaces for cooling fluid and has a centrally drilled hole 7, through which the piston rod 5 of the working piston passes. The bore 7 is provided with a number of piston rings 8 inserted in annular grooves, the said piston

ings exerting pressure on the piston rod 5 n a suitable degree. The controlling piston 14 is provided with externally arranged pis- on rings 9 in the usual way. During scav- enging of the lower half of the cylinder the products of combustion are expelled through the ports 3′ uncovered by the distributing piston 14, the said ports being surrounded by an annular chamber 31 connected to the exhaust pipe at the flange 32. The construc- tional form illustrated in Fig. 5 is similarly intended for use in double-acting engines, and the scavenging air ports 2 at the middle of the cylinder are covered and uncovered by the working piston 4. The cylinder 1 has an upper cover 18 on which is mounted a cylinder 19 in which the distributing or con- trolling piston 6, controlling the exhaust ports 3, reciprocates. The cylinder 1 has further a bottom cover 27 with a cylinder 30 and a controlling or distributing piston 14 controlling the exhaust ports 3′ in a way similar to that described in connection with Fig. 4. The two distributing pistons 6 and 14 are interconnected by means of crosshead beams 11 and 16 and rods 15, so that the motions of the two distributing pistons are identical, their motion being essentially op- posite that of the working piston 4 and of the same cycle. To the bottom ends of the rods 15 are secured crossheads 35 recipro- cating in guides 36 mounted on the engine frame. By means of the connecting rods 37 the motion is transferred to the crank shafts 38 which are connected with the main crank shaft in any suitable manner, for instance by means of gear wheels, chain drive or the link rod mechanism illustrated in Fig. 6. In this constructional form scavenging is effected in a way similar to that described with regard to Fig. 4. The link mechanism illustrated in Fig. 6 connecting the secondary shafts 38 shown in Fig. 5 with the main shaft 39 con- sists of two congruent triangles a, b, c and a_1, b_1, c_1 each comprising three linkably con- nected rods whose ends are rotatably con- nected with two sets of cranks on the three shafts. This link rod device makes it pos- sible in a very simple manner to transmit considerable quantities of work between the two secondary shafts 38 and the main shaft 39. When the scavenging arrangements ac- cording to Figs. 4 and 5 are employed provi- sion is made—similarly to what has been described in connection with Fig. 1—that the scavenging air obtains a whirling motion during admission by a suitable shaping of the scavenging air ports, just as provision may be made, if desired, for the fuel being introduced into the engine cylinder in direc- tions following the rotating motion of the scavenging air, or in directions opposite this rotating motion. The invention is not re- stricted so as to comprise only the construc- tional forms here described and set forth as the various details of construction may be performed or combined in any other way. For instance, similar rods as the rods 12 shown in Fig. 4 may be used in the construc- tional form according to Fig. 5 for transfer- ring the motion of the pistons 6 and 14 direct to the main shaft. Similarly in the construc- tional forms according to Figs. 1 to 4 the arrangement of two crank shafts 38 or the like may be made use of, as described in connec- tion with Fig. 5.

An increasement of the effect obtained by the above mentioned devices is constituted by the effect, which is obtained by the special arrangements appearing from Figs. 1 and 5, viz., that the exhaust ports 3 are made essen- tially smaller than the scavenging air ports 2, and according to the invention even so small, that the exhaust current, due to the small size of the passage area of the exhaust ports, is throttled without the employment of special throttling means.

Hereby throttling is obtained in a simple and cheap manner, which throttling as known causes an increasement of the pressure in the cylinder during the last part of the scavenging period, so that the cylinder at the beginning of the compression period will con- tain a greater quantity of air than normally, which means an increased output of the cyl- inder.

I claim:

1. In a two-stroke internal combustion en- gine, the combination of a cylinder having a plurality of scavenging and exhaust ports therein, a power piston in said cylinder, said scavenging ports being directed tangential- ly to a cylindrical surface disposed within the inner wall of the cylinder and arranged coaxially therewith and controlled by said power piston, said exhaust ports being dis- posed in the end of said cylinder opposite the end containing said scavenging ports, and a second piston having a velocity which is less than the velocity of said power piston for controlling said exhaust ports, said diameter of the piston controlling the exhaust ports being less than the diameter of the power piston.

2. In a two-stroke internal combustion en- gine, the combination of a cylinder having a plurality of scavenging and exhaust ports therein, a power piston in said cylinder, said scavenging ports being directed tangential- ly to a cylindrical surface disposed within the inner wall of the cylinder and arranged coaxially therewith and controlled by said power piston, said exhaust ports being dis- posed in the end of said cylinder opposite the end containing said scavenging ports, and a second piston for controlling said exhaust ports having a bore therein through which the piston rod of the power piston extends.

3. In a two-stroke internal combustion en- gine, the combination of a cylinder having

scavenging ports therein, said scavenging ports being directed tangentially to a cylindrical surface disposed within the inner wall of said cylinder and arranged coaxially therewith, a cylinder cover on said cylinder, a second cylinder arranged in said cylinder cover having a plurality of exhaust ports therein, a power piston in said first cylinder, a second piston in said second cylinder, said scavenging ports being controlled by a power piston and said exhaust ports being controlled by said second piston.

4. In a double acting two-stroke internal combustion engine, the combination of a main cylinder having a plurality of scavenging ports therein, being directed tangentially to a cylindrical surface disposed within the inner wall of said cylinder and arranged coaxially therewith, an upper cover on said cylinder, a second cylinder arranged in said cover and having exhaust ports therein a lower cover on said cylinder a third cylinder arranged in said lower cover and having exhaust ports therein, pistons in each of said cylinders in said covers for controlling said exhaust ports, a power piston in said main cylinder adapted to control said scavenging ports, and means interconnecting said pistons in said cylinder covers whereby the motion of said pistons are identical.

5. In a double acting two-stroke internal combustion engine, the combination of a cylinder having scavenging ports therein, being directed tangentially to a cylindrical surface disposed within the inner wall of said cylinder and arranged coaxially therewith, a cover on the lower extremity of said cylinder, a second cylinder arranged in said cover having exhaust ports therein, a working piston in said main cylinder, a second piston in said second cylinder, said main cylinder having exhaust ports in the upper part thereof, and valves for controlling said exhaust ports.

6. In a double-acting two-stroke internal combustion engine, the combination of a main cylinder having a plurality of scavenging ports therein, being directed tangentially to a cylindrical surface disposed within the inner wall of said cylinder and arranged coaxially therewith, an upper cover on said cylinder, a second cylinder arranged in said cover and having exhaust ports therein, a lower cover on said cylinder, a third cylinder arranged in said lower cover and having exhaust ports therein, pistons in each of said cylinders in said covers for controlling said exhaust ports, a power piston in said main cylinder adapted to control said scavenging ports, means interconnecting said pistons in said cylinder covers whereby the motion of said pistons are identical, crank shafts connected to each of said pistons in said cylinder covers, a main crank shaft connected to said power piston, and a congruent triangular link system interconnecting said secondary crank shafts and said main crank shaft.

7. In a two-stroke internal combustion engine, the combination of a cylinder having a plurality of scavenging and exhaust ports therein, a power piston in said cylinder, said scavenging ports being directed tangentially to a cylindrical surface disposed within the inner wall of the cylinder and arranged coaxially therewith and controlled by said power piston, said exhaust ports being disposed in the end of said cylinder opposite the end containing said scavenging ports, and a second piston having a velocity which is less than the velocity of said power piston for controlling said exhaust ports, said diameter of the piston controlling the exhaust ports being less than the diameter of the power piston, the passage area of said exhaust ports being smaller than the passage area of the scavenging ports.

8. In a two-stroke internal combustion engine the combination as set forth in claim 1, in which the axis of the power piston and of the second piston are parallel.

9. In a two-stroke internal combustion engine the combination as set forth in claim 1, in which the axis of the power piston and of the second piston lie in the same line.

10. In a two-stroke internal combustion engine the combination as set forth in claim 1, in which the piston controlling the exhaust ports moves in a cylinder which is connected with the cylinder of the power piston through a wall having a curved inner surface.

11. In a two-stroke internal combustion engine the combination as set forth in claim 3, in which the part of the cover connecting the cylinders of the power piston and the second piston is shaped with a curved inner surface.

In testimony whereof I affix my signature.

TORKILD VALDEMAR HEMMINGSEN.